Patent Claims

1. An image processing system (1), in particular for omnidirectional reading of optical patterns, for example one-dimensional and two-dimensional codes (18), comprising at least:
an imaging system (2) for provision of image data,
an analog/digital converter (4) for conversion of the image data to digital image data (12),
a processing device (6) for processing of the digital image data (12),
a computation device (8) and
a plurality of convolvers for convolution of the digital image data.

2. The image processing system (1) as claimed in claim 1, wherein the digital image data (12) is convolved by means of the plurality of convolvers which operate in parallel in time and/or operate using the time-division multiplexing method.

3. The image processing system (1) as claimed in one of the preceding claims,
wherein the digital image data is formed from an incoming image datastream (12), and the incoming image datastream (12) is convolved by means of the plurality of convolvers which operate in parallel in time and/or operate using the time-division multiplexing method.

4. The image processing system (1) as claimed in one of the preceding claims,
wherein the image data represents an at least two-dimensional image, and the convolvers operate in different directions (0°, 45°, 90°, 135°).

5. The image processing system (1) as claimed in one of the preceding claims,

wherein the convolvers comprise a plurality of pairs of convolvers (54), and the digital image data (12) is convolved (Fx_0, Fx_1) by means of the plurality of pairs of convolvers (54) which operate in parallel in time and/or operate using the time-division multiplexing method, and
wherein the two convolvers (54) in one pair operate in the same direction (0°, 45°, 90°, 135°).

6. The image processing system (1) as claimed in one of the preceding claims,
wherein the digital image data (12) is convolved (Fx_0, Fx_1) by means of four pairs of convolvers (54), which operate in parallel in time and/or using the time-division multiplexing method, and operate in four directions (0°, 45°, 90°, 135°) which are each rotated through 45°.

7. The image processing system (1) as claimed in one of the preceding claims,
wherein the digital image data (12) is convolved (Fx_0, Fx_1) within an n x n, in particular 6 x 6 environment.

8. The image processing system (1) as claimed in one of the preceding claims,
wherein the digital image data is an incoming image datastream (12) and, in a first main process in the processing device (6), the incoming image datastream (12) is convolved within an n x n environment by means of the plurality of convolvers which operate in parallel in time and/or using the time-division multiplexing method and which operate in respectively rotated directions (0°, 45°, 90°, 135°).

9. The image processing system (1) as claimed in one of the preceding claims,
wherein contour points (22) are produced by means of the

convolution results (Fx_0, Fx_1), and a subset of the contour points (22) is entered in a contour point list (20).

10. The image processing system (1) as claimed in one of the preceding claims,
wherein operands for a logical decision are determined by means of the convolution results (Fx_0, Fx_1) from the convolvers (54), and
wherein the image processing system (1) has a decision unit (60) which provides a logical variable (B[k]) as a function of the operands, and a contour point (22) is entered in a contour point list (20) as a function of the logical variable (B[k]).

11. The image processing system (1) as claimed in one of the preceding claims,
wherein a contour point (22) is entered in a contour point list (20) as a function of the logical variable (B[k]) at least with the values X position, Y position and the associated contrast value (CONT).

12. The image processing system (1) as claimed in one of the preceding claims,
wherein the logical variable is a Boolean vector B[k] with a plurality of logical variables (k = 1,2,…), and
wherein a first of the logical variables B[1] depends on a threshold value of the absolute magnitude of the difference between the convolution results (Fx_0, Fx_1) which are associated with one convolver pair (54) being exceeded,
a second of the logical variables B[2] depends on a mathematical-sign difference between the convolution results (Fx_0, Fx_1) which are associated with one convolver pair (54),
a third of the logical variables B[4] depends on whether one of the convolution results (Fx_0, Fx_1) which are

associated with one convolver pair (54) is equal to zero, and
wherein a contour point (22) is entered (Contour_Point_valid) in a contour point list (20) as a function of a logic operation on the first, second and/or third logical variables.

13. The image processing system (1) as claimed in Claim 12, wherein the logic operation comprises at least the Boolean operation:
B[1] AND {B[2] OR B[4]}, and the contour point (22) is entered in the contour point list (20) when the result of the logic operation is TRUE.

14. The image processing system (1) as claimed in one of the preceding claims,
wherein one convolver pair (54) is provided for each direction (0°, 45°, 90°, 135°), and one contour point list (20) is in each case created for each direction.

15. The image processing system (1) as claimed in one of the preceding claims,
wherein a contour point (22) is entered in a contour point list (20) in a memory at least with the values X position, Y position and contrast value (P(X,Y, contrast value)) precisely
when a) the convolution results (Fx_0, Fx_1) of the operands which are associated with one convolver pair (54) have different mathematical signs and the difference between the operands in the predetermined direction exceeds a threshold value, or
when b) one and only one operand is equal to zero, and the difference between the operands in the predetermined direction exceeds a threshold value (Fx_Threshold).

16. An image processing system (1), in particular for omnidirectional reading of optical patterns, for example

one-dimensional and two- dimensional codes (18), in particular as claimed in one of the proceeding claims, comprising at least:
an imaging system (2) for provision of image data,
an analog/digital converter (4) for conversion of image data which has been provided by the imaging system to digital image data (12),
a processing device (6) for processing the digital image data,
a computation device (8) and
a neighborhood processor (90) for reading and linking contour points (22).

17. The image processing system (1) as claimed in claim 16, wherein, in a second main process which is delayed in time with respect to the first main process, contour points (22, P(X,Y, contrast value)) of adjacent lines and/or columns (j, j-1) are read by the neighborhood processor and are then linked and are entered into a contour point list (20) when a neighborhood criterion (NC) is satisfied.

18. The image processing system (1) as claimed in claim 17, wherein the neighborhood is a function of the contour point separation and/or the contrast values (CONT) of the adjacent contour points (22).

19. An image processing system (1), in particular for omnidirectional reading of optical patterns, for example one-dimensional and two-dimensional codes (18), in particular as claimed in one of the proceeding claims, comprising at least:
an imaging system (2) for provision of image data,
an analog/digital converter (4) for conversion of image data which has been provided by the imaging system to digital image data (12),
a processing device (6) for processing the digital image

data,
a computation device (8) and
a statistical processor for reading a segment list.

20. The image processing system (1) as claimed in claim 19, wherein the segment list is a contour point list to which at least one segment number has been added.

21. The image processing system (1) as claimed in one of the preceding claims,
wherein an object association is carried out on the contour points (22), preferably in the processing device (6).

22. The image processing system (1) as claimed in one of the preceding claims,
wherein, in a third main process which is delayed in time with respect to the second main process, the segment list is read by the statistical processor, and
wherein the statistical moments (S) are calculated for the objects in each direction (DIR1 to DIR4).

23. The image processing system (1) as claimed in one of the preceding claims,
wherein, in a third main process which is delayed in time with respect to the second main process, the segment list is read by the statistical processor, and
wherein the statistical moments (S) are calculated in a multiplier/accumulator as far as the second, third and/or fourth order for the objects in each direction (DIR1 to DIR4).

24. The image processing system (1) as claimed in one of the preceding claims,
wherein the image data is supplied as an image datastream (12) to the processing device (6), and the contour point list (20) is actually produced while the

image datastream (12) is being supplied.

25. The image processing system (1) as claimed in one of the preceding claims,
wherein partitioned contour point lists (20) which have been sorted on the basis of directions are stored in one or more memories with respect to the delay time of the image.

26. The image processing system (1) as claimed in one of the preceding claims,
wherein a pixel interpolation process is carried out in order to reduce the quantization or digitization noise.

27. The image processing system (1) as claimed in one of the preceding claims,
wherein the contour points (22) are stored with sub-pixel resolution in the contour point list (20).

28. The image processing system (1) as claimed in one of the preceding claims,
wherein at least one gradient (Grad_1, Grad_2) is calculated for each direction (DIR1 to DIR4), and is preferably stored in the contour point list.

29. The image processing system (1) as claimed in one of the preceding claims,
wherein the difference between two convolution results (Fx_0 - Fx_1) is calculated, and is preferably stored in the contour point list (20).

30. The image processing system (1) as claimed in one of the preceding claims,
wherein a gradient or a plurality of gradients (Grad_1, Grad_2) and the difference between two convolution results (Fx_0 - Fx_1) are calculated in the respective filter direction with respect to the delay time of the

image, and one of the gradients and/or said difference is stored as a contrast (CONTx) within the contour point list (20).

31. The image processing system (1) as claimed in one of the preceding claims,
wherein the contents of the contour point list (20) for each direction are copied to a memory (M1).

32. The image processing system (1) as claimed in one of the preceding claims,
wherein the contents of the contour point list (20) are copied from the processing device (6) for each direction after each line of the imaging system to a preferably external memory (M1).

33. The image processing system (1) as claimed in one of the preceding claims,
wherein a segmentation process is carried out in the processing device (6).

34. The image processing system (1) as claimed in one of the preceding claims,
wherein an interface (34) of a data storage unit (36) copies the current line from the contour point list (20), after processing progress of a neighborhood processor (90), separately on the basis of directions to a general purpose memory (M2) of the neighborhood processor (90).

35. The image processing system (1) as claimed in one of the preceding claims,
wherein the neighborhood processor (90) uses a neighborhood criterion (NC) to define neighborhoods, to segment contour points (22) and/or to enter the segment numbers and coincidences in an extended contour point list (20).

36. The image processing system (1) as claimed in one of the preceding claims,
wherein a statistical processor calculates moments (S) on the basis of the contour point list (20).

37. The image processing system (1) as claimed in one of the preceding claims,
wherein the image processing system (1) outputs data via an output interface, in the following output format: [Direction(DIR), Moments(S), Segment number (SegNo), Contrast(CONT)].

38. The image processing system (1) as claimed in one of the preceding claims,
wherein an illumination device is included.